OMSO2 Release Specific Information

Software Version

The current release of OMSO2 is version 1.0.0

ECS Collection Number 2

OMSO2 v1.0.0 is the first public release of the software designed to produce total column sulfur dioxide from OMI data. Changes made in subsequent versions will be listed below, in the Release History.

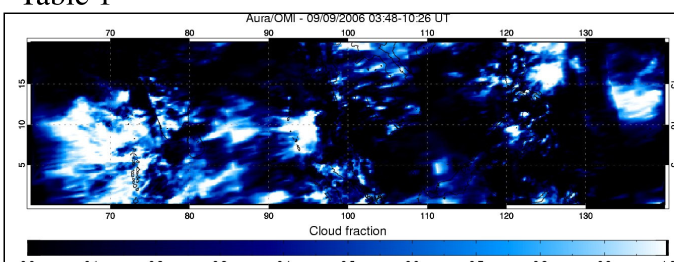
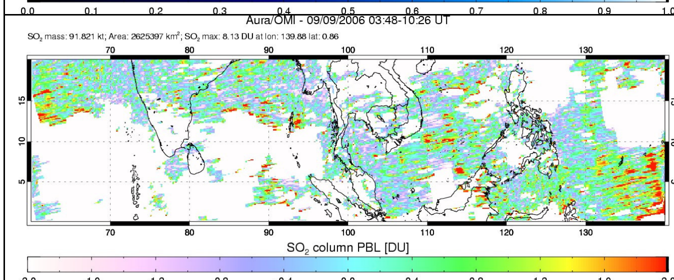
Known Issue List

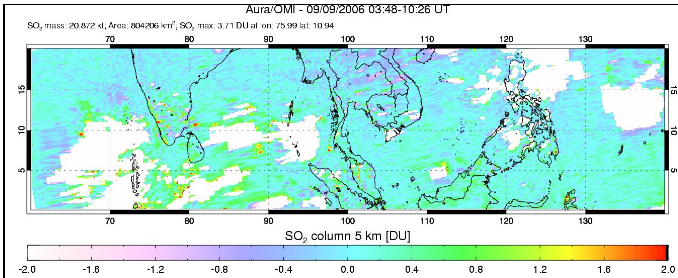
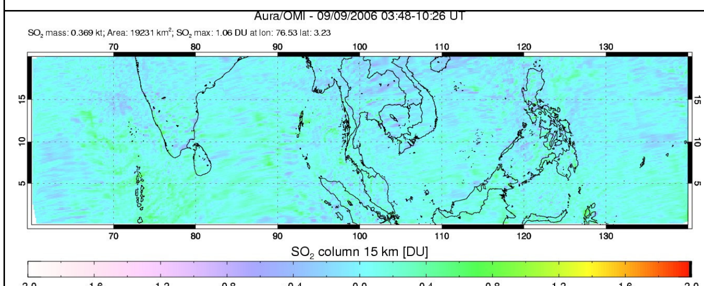
Biases exist in OMSO2 retrievals; these are currently under evaluation. This section describes significant issues unique to the OMSO2 v1.0.00 product:

1) Data collected over the South Atlantic and South America (from southern Peru southward) are affected by the South Atlantic Anomaly (SAA). Higher particle fluxes in this region result in random isolated spikes in SO_2 that are not yet filtered out.

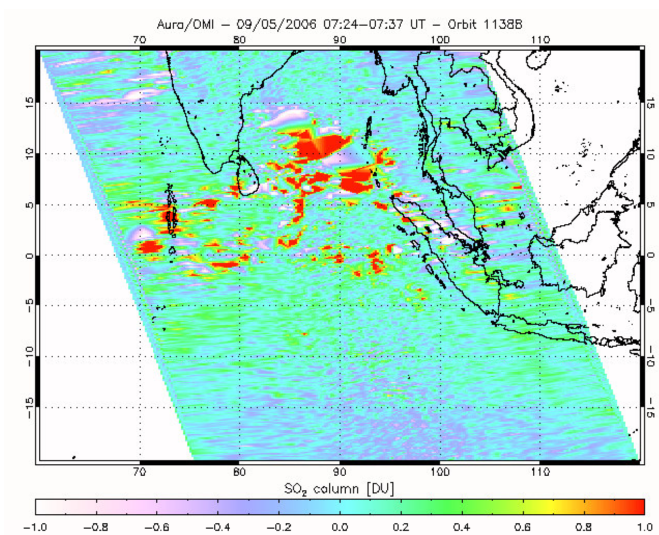
2) In the OMSO2 data there is cloud screening. The screened regions contain fill values. The screening criteria are different for PBL and 5km data as described in Table 1. The cloud-related fill values are possible in 5km data when the assumed cloud top (from OMTO3 climatology) is higher than 10 km.

Table 1

<table>
<tr><td>
</td><td>OMTO3 cloud fraction on September 9 2006.</td></tr>
<tr><td>
</td><td>In the PBL data, all pixels with OMTO3 reflectivity (LER) larger than 30% are screened. The assumption is that clouds always screen PBL SO2. The PBL AMF does not account for this cloud screening effect on SO2, so the data reported for partially cloud conditions are underestimations of the real SO2. This cloud related error becomes larger with increasing sub-pixel cloudiness, so that fill values are used if OMTO3 cloud fraction larger than ~23%.</td></tr>
</table>

	In the 5km data the cloud-related fill values have to do with the small dN/dSO2 values. If the cloud is higher than 10 km or so (according to IR cloud top height climatology used in OMTO3), most of the 5KM SO2 is blocked by the cloud. As a result, dN/dSO2 becomes very small or even zero. This basically says one cannot derive SO2 below the clouds. In these cases, no retrieval is done and fill value is stored in the output.
	In the 15 KM product, the same criteria are applied, but no cloud is high enough to block the SO2. Retrievals are always attempted. One should see no fill values due to cloud blocking in the 15KM data field.

3) The 5 km SO2 artifacts in the Sept 1 - 11 2006 average plot are related to clouds, but not in a simple way. On a single orbit, the retrievals become noisier at LER < 30% with the standard deviation about 3 times greater than at lower LER. The noise is almost symmetrical with + and - deviations nearly canceling so that the average is still near zero. For some reason they don't seem to cancel in the 12 day average. The relation to ozone is similar to reflectivity, with higher noise occurring at higher ozone amounts. The artifacts occur only near the equator in this time period, so maybe scattering angle has something to do with it.



4) Significant differences are found between pairs under some meteorological situations. These effects are greatly reduced by averaging the three pairs. A small latitude-dependent bias in background regions is generally within 0.5 DU. Clouds also produce small biases. Volcanic clouds are detected with good fidelity because they generally contain much higher amounts than these background biases. Air pollution SO_2 levels are comparable to these bias levels so that care must be taken in interpretation of the results.

Aerosols are known to produce errors in volcanic SO_2 retrievals (Krueger et al., 1995). The effects on PBL retrievals are under evaluation.

5) For this release of OMSO2 (v1.0.0.0), we caution that data taken at polar latitudes may be unreliable due to high solar zenith angles and/or high total ozone amounts and increased residual sensitivity to ozone profile shape. Note that, as any suspect pixels are removed by the OMTO3 PGE before input to OMSO2, the pixel quality flags in OMSO2 are not yet fully functional. These will be implemented in a future release of OMSO2 when aerosol and other effects on SO_2 retrievals are better understood.

Release History

OMSO2 v1.0.00 contains several modifications from the provisional release (OMSO2 v0.9.29.1) The primary differences are in the new temperature dependent SO2 cross sections data [Bogumil et al 2000], new residual correction for background regions, different parameterization of the Air Mass Factors, and in high SO2 volcanic retrievals:

1. Instrument calibration errors are corrected by assuming median residuals are zero in background regions for each scan position (moving median method). This correction removes latitude dependent zero offsets in the retrievals.

2. When the atmospheric SO2 loading is low (<10 DU), the linear Band Residual Difference (BRD) algorithm (Krotkov et al., 2006) is suitable for SO2 retrieval. The BRD algorithm uses differential residuals at 3 most SO2 sensitive OMI UV2 wavelength pairs, and this is used to produce all PBL data in the OMSO2 product. The BRD is a two-step algorithm: it first estimates pair average slant column SO2 amount (SC), which is converted to the vertical column (VC) by dividing with a constant Air-Mass Factor (AMF=0.36): VC=SC/AMF.

3. For strong volcanic degassing and eruptions, SO2 loading can be very large and the BRD algorithm may fail. The new linear Fit (LF) algorithm has been developed to optimally select residuals from the set of available OMTO3 bands to retrieve SO2 under these conditions. The LF algorithm minimizes a subset of the residuals by simultaneously adjusting VC SO2, total column ozone, reflectivity at 331nm, and polynomial coefficients (linear and quadratic) to account for the wavelength dependent effect of surface albedo and aerosol on the effective reflectivity. In the OMSO2 product, 5 km and 15 km data processed with the LF algorithm are provided, in addition to BRD retrievals for the same vertical distributions.

The Maximum Likelihood algorithm originally developed for operational SO_2 processing will be operationally employed when the OMI instrument calibration is better understood. This algorithm has maximum sensitivity for SO_2 in the PBL. For a description of this algorithm please refer to ATBD-OMI-04, *OMI Trace Gas Algorithms*, in Algorithm Theoretical Basis Document (ATBD), which also contains other algorithm related documents.

References

Bogumil, K., J. Orphal, T. Homann, S. Voigt, P. Spietz, O.C. Fleischmann, A. Vogel, M. Hartmann, H. Kromminga, H. Bovensmann, J. Frerick, J.P. Burrows, Measurements of molecular absorption spectra with the SCIAMACHY pre-flight model: instrument characterization and reference data for atmospheric remote-sensing in the 230-2380nm region, Journal of Photochemistry and Photobiology, A:Chemistry, 157 , 167-184, 2003.

Krotkov, N, A. , S. A. Carn, A.J. Krueger, P.K. Bhartia, K. Yang, Band residual difference algorithm for retrieval of SO2 from the AURA Ozone Monitoring Instrument (OMI), *IEEE Transactions on Geoscience and Remote Sensing*, *AURA special issue*, 44(5), 1259-1266, doi:10.1109/TGRS.2005.861932, 2006

Krueger, A.J., L.S. Walter, P.K. Bhartia, C.C. Schnetzler, N.A. Krotkov, I. Sprod, and G.J.S. Bluth(1995). Volcanic sulfur dioxide measurements from the total ozone mapping spectrometer instruments. J. Geophys. Res., 100(D7), 14057-14076, 10.1029/95JD01222.